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A method for producing embossing plates

B Background of The Invention

B 1. Field of the Invention

This invention relates to a method for producing embossing plates, in particular

B steel intaglio printing plates, ~~according to the preamble of claim 1.~~

B 2. Description of Related Art

For producing embossing plates, in particular steel intaglio printing plates, as are usually employed for printing high-quality printed products such as papers of value, bank notes or the like one has hitherto resorted to having the embossing plates produced in an elaborate method by an artist. A picture motif made available to the artist is converted into a line pattern whereby lines of different width, depth and a different number per unit area represent the gray levels of the original. Using a chisel, the artist brings this motif in time-consuming hand labor into the metal plate, for example steel or copper. The thus produced plates are characterized by their high quality with respect to use in steel intaglio printing. However the possibilities of correction are extremely low for the artist during production of the plate. If this original plate is damaged or lost, no identical plate can be produced since each plate is an individual production.

It is also known to perform the engraving of a printing cylinder by machine. As described in EP 0 076 868 B1 for example, cups are brought into the printing form which represent the gray level value of a master depending on their screen width and engraving depth. Light tones and tone-dependent changes in the master are produced by varying the focal value of the electron beam in the printing form, whereby cups of different volume can arise.

From DE 30 08 176 C2 it is also known to use a laser for engraving a printing cylinder. An original is scanned and the resulting signal used via an analog-to-digital converter for controlling the laser with which engraved cups of defined depth and extension are brought into the printing cylinder.

When the original is broken down into gray-level values represented on the printing plate by cups, the essential components necessary for steel intaglio printing are lost, since this technique is only able to transfer ink to the print carrier point by point. Steel intaglio printing, however, is characterized by the fact that a continuous

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linear printing pattern tangible with the inking is transferred to the print carrier, characterized in particular by its filigreed design.

Summary of The Invention

B The objective ~~problem~~ of the invention is accordingly to propose a method permitting simple and automated production of embossing plates, in particular steel intaglio printing plates.

B ~~This problem is solved by the characterizing features of claim 1.~~

Sub C6 The invention is based on the finding that it is possible to treat a two-dimensional line original graphically such that the existing lines are interpreted as areas. These areas are limited by edges, these edges defining a desired contour of the area. Starting out from this desired contour one determines a tool track along which an engraving tool can be guided such that material is removed within the area limited by the desired contour. The engraving tool is controlled such that the material within the desired contour is removed in the form of continuous or interrupted lines in a certain depth profile. This depth profile can be determined by a depth value that is constant or varies within the desired contour.

Sub G6 The inventive method preferably makes use of a data processing system which makes it possible to acquire, store and process two-dimensional line originals. The two-dimensional line original, which is for example produced in a computer or read in via input devices, can be processed with the aid of a suitable computer program so as to yield data for controlling an engraving tool along a tool track. For this purpose one defines in a first working step from the two-dimensional line original a plane element which consists for example of a single line of the line original. The edge enclosing the line then defines a desired contour which is intersection-free. To produce the engraving one associates a depth profile with the interior of the plane element as the desired depth for the engraving, and then calculates from the desired contour data and the associated desired depth a tool track along which the engraving tool is guided and removes material within the plane element.

This procedure is then repeated for each individual plane element to be engraved so that an engraving tool track can be determined for the entire area to be engraved, composed of the sum of the individual plane elements to be engraved.

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Using this method one can considerably increase the speed for producing the embossing plate. Furthermore, errors during engraving are excluded by the exact guidance of the engraving tool so that a multiplicity of embossing plates can be produced with the same exactness. In addition the method offers simple possibilities of correction by changing the data of the line drawing. The exact reproducibility of the engraving to be brought in furthermore permits printing plates to be produced directly without any need for a galvanic shaping process. Several engraving tools can thereby also engrave several plates simultaneously. Furthermore several, possibly different, engraving tools can also be controlled such that they process a plate simultaneously, thereby optimizing the processing time.

Further advantages and advantageous embodiments will be explained with reference to the following figures, in which a true-to-scale representation was dispensed with for the sake of clearness.

Brief Description of The Drawings

Fig. 1 shows a schematized overall view of the inventive method,

Fig. 2 shows a schematic example of the inventive method,

Fig. 3 shows a schematic example of the inventive method,

Fig. 4 shows a schematic example of the inventive method,

Fig. 5 shows a schematic example of the inventive method,

Fig. 6 shows a schematic cross section through an embossing plate,

Fig. 7 shows a schematic example of the inventive method,

Fig. 8 shows a schematic example of a tool track,

Fig. 9 schematically shows two tool point forms,

Fig. 10 shows a schematic cross section through an embossing plate,

Fig. 11 shows a schematic cross section through an embossing plate.

B9 Ins. C?> Detailed Description of The Preferred Embodiments

As shown in Fig. 1, the inventive method starts out from two-dimensional line original 1, consisting of simple black line 2 on light background 3 to illustrate the inventive principle. The original, which is present on paper for example, can be digitally acquired in a computer with the aid of a scanner or another suitable data input means. Alternatively it is also possible to produce the line original directly on the computer interactively, using for example a plotting or graphics program, or to have the computer produce certain graphic data by mathematical algorithms. If the

original is designed in the latter way, guilloche lines or other graphic elements could be produced for example with the aid of implemented programs which permit interactive input or presetting of data or calculation of the structures with the aid of random algorithms. From line original 1 one defines in a second method step an area, e.g. area 4, which represents a partial area of the plate. The edge of this area defines desired contour 5 which serves as the first of two elements as the starting point for subsequent calculation of a tool track along which the embossing plate is to be engraved. As the second element for calculating the tool track it is necessary to associate a depth profile within the desired contour, which is termed the so-called desired depth. This can be preset constantly for the entire engraving for example. It can also depend on the form of the engraving tool used. From desired depth 6 and desired contour 5 one then calculates tool track 10 located within area 4 along which the engraving tool must be moved so that the engraving corresponding to the line drawing can be brought into the embossing plate.

Since different engraving tools can be used for engraving the plate, it is clear that data of the particular engraving tool also enter into the calculation of the tool track. If a laser beam is used, the width of the beam acting on the embossing plate can be included in the calculation for example. If a mechanical chisel is used, the chisel form, in particular the form of the point or its radius of curvature, is of essential importance for calculating the tool track.

The engraving tool is controlled subsequent to the determination of the tool track such that it moves within area 4, does not hurt desired contour 5 during engraving and removes area 4 at predetermined desired depth 6.

In a specific embodiment, shown in Fig. 2, the number "7" is produced as a line original on a sheet of paper and read into a computer with the aid of a scanner. The number "7" consists of lines 7, as shown in Fig. 2(a). Using the above-described procedure one defines from existing lines 7 areas 8 whose edges form desired contours 9, as shown in Fig. 2(b). These serve as a starting point for calculating a tool track. Through the association of a desired depth, which is constant in this case, one can determine with consideration of the particular tool data tool tracks 10, 11 and 12 along which the engraving tool is controlled over the embossing plate so that the line

drawing can be transferred to the embossing plate. These tool tracks are shown by way of example in Fig. 2(c). Tool tracks 10, 11 and 12 are preferably determined such that the tool is guided along desired contours 9 within areas 8 without hurting the desired contours.

Since the width of the material removed with the engraving tool is limited, one can define via the line drawings plane elements with a size which cannot be removed completely if the engraving tool is guided only along the desired contour lines. A very simple form of line drawing is shown by way of example in Fig. 3. Via the line drawing of Fig. 3(a) one defines plane element 8 having contour line 9. When tool track 13 is now calculated on the basis of these given data, as shown in Fig. 3(b), the engraving tool cannot in one cycle completely remove the area to be removed, depending on the dimensioning of area 8 and the form of the engraving tool.

B10 For rotating 14 chisel these relations are shown in perspective in Fig. 4. B10 Chisel 14 rotates about its own axis z and, after penetrating into embossing plate 15, removes material from the embossing plate along tool track 13 at a predetermined depth. Due to the guidance of rotating chisel 14 along tool track 13, desired contour line 9 remains intact. Because of the limited width of the chisel, however, residual area 16 of area 8 to be removed cannot be removed in one cycle of the engraving tool. Only in a further operation can residual area 16 be removed using a second predetermined tool track, which can differ in form from first tool track 13.

Sub C8 As to be seen in Fig. 5(a), it is necessary in this case also to consider residual area 16 not removable in the first step when calculating the tool track for removing area 8. For removing residual area 16 one can determine different tool tracks depending on the desired engraving results. Thus the tool track can, as shown in Fig. 5(b), first extend along the desired contour and residual area 16 then be removed in a meander shape, the engraving tool removing the residual area continuously in meander-shaped track 17 within area 16. Fig. 5(c) shows a further possibility whereby residual area 16 is removed by guidance of the engraving tool along tool tracks which are similar in the mathematical sense to tool track 12 first calculated, i.e. tool tracks 18, 19 and 20 correspond to tool track 12 in form but have a different dimension from tool track 12. Particularly in the case of curved contour lines, residual area

16 can accordingly be removed using tool tracks which extend contour-parallel, i.e. are equidistant from the contour line at each point.

As to be seen in Fig. 6(a) in a cross section through embossing plate 15, one calculated from contour line 9 a tool track along which the engraving tool was guided, thereby producing engraved line 28 enclosing residual area 16 yet to be engraved. To remove residual area 16 one can use any method but preferably one of the above-described. Regardless of the particular method one produces at the base of the residual area engraving a defined roughness structure determined by the offset and form of the engraving tool. Fig. 6(b) shows such a roughness structure, whereby a tapered, rotating graver was used for engraving, removing the embossing plate at defined depth *T*. The chisel used had diameter *D* on the surface emerging from the embossing plate and was offset inward by the amount *d*/2 during removal of the residual area, while the offset is 3/4 *d* in the example shown in Fig. 6(c). The engraving tool was moved in accordance with the tool tracks shown in Fig. 5(c) in both examples.

B The described surface structuring at the base of the engraved area ~~embossing~~ has several advantages for producing steel intaglio printing plates. Using steel intaglio printing plates one could hitherto print only limited line widths, due to the fact that the steel intaglio printing ink can only be brought into engravings of the plate which have a certain maximum width. This obstacle is eliminated by the newly proposed engraving since one can now adjust the roughness as a base pattern at the base of the engraving to serve as an ink trap for a steel intaglio printing ink brought in. This ink can thus be held even in very wide engraved lines so that it is now possible for the first time to print wide lines by steel intaglio printing. As shown in Figs. 6(b) and 6(c), the roughness of the base can be controlled via the size of the engraving tool offset. Since different offset widths of the chisel can also be considered in the calculation of the tool track, the roughness can be different at the base in different areas of the residual area and thus the engraved line or area be superimposed with an additional modulation of the roughness of the base pattern. It is thus also possible to bring further information into an engraved line solely by selectively producing the roughness of the base pattern.

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Since transparent inks are usually employed in steel engraving, a different color effect within a line can be produced on the document to be printed with the aid of the different engravings within a line. This color effect can be improved further in particular if the engraving already produced is provided in a further method step with a second engraving whose desired depth has a different definition from that of the first engraving. Fig. 7 shows an example of this in which line drawing 18 with lines 19 is present. Lines 19 are limited by desired contour lines 20. Within lines 19 there are areas 21 limited in turn by second desired contour lines 22. This line original is brought into a computer as a digital data image or produced directly therein. As shown in a detail in Fig. 8, one calculates from contour lines 20, together with a desired depth firmly preset in this case, tool track 23 along which a first engraving takes place. Any remaining residual area is removed at a given desired depth, as described above. Area 21 located within line drawing 19 is converted into tool track 24 in the same way, the contour of area 21 and a second desired depth different from the first being included in the determination of the tool track as a basis for conversion. One can thus produce engravings containing additional information even over a large surface area, which can be transferred to the document at the same time by the steel intaglio printing process.

The tapered edges of line drawing 19 can be rendered exactly by a suitable choice of chisel form. It is possible to use a single fine chisel for the engraving, or rework the tapered edges with a fine chisel after engraving the area with a coarse chisel. As an alternative to this possibility one can also adapt the depth profile to the requirements of area 19 to be engraved. In this case the depth profile is preset such that the engraving tool removes less material at the tapered edges so that, in particular if a rotating mechanical chisel is used, the chisel emerges ever further out of the material to be processed and due to the conic form therefore the removed line becomes narrower. These two techniques can also be used for exact engraving of corners or edges.

For determining the tool track one generally combines a determined desired contour with an engraving depth profile according to the inventive method, thus determining from these two data a tool track along which the engraving tool is guided,

so that the material can be removed in accordance with the line drawing at the depth corresponding to the depth profile. The depth profile, i.e. the desired depth, can be preset for each individual engraved line or for the engraving altogether as a constant. Desired depths can also be different for individual engraved lines or parts of engraved lines, so that the particular tool track is accordingly modulated. In addition it is possible to use different engraving tools of like or different kinds in successive method steps in order to produce the desired engraving result. If rotating mechanical chisels are used it is especially advantageous to use different chisel points, forms and sizes, so that optimal embossing plates can be produced in this way.

By producing and using different chisel forms and sizes one can influence the embossing result in a variety of ways. Precisely the form and size of the embossing tool determine the form of the thus produced engraving cross-sectional area, depending on the penetration depth of the engraving tool into the plate. Fig. 9 shows two examples of possible cross-sectional areas of chisel points. In Fig. 9(a) the chisel point is formed so that intersecting line 28 of the envelope of the cone forms a 45° angle with axis of rotational symmetry *S* of the engraving tool. Engraving the plate with this tool thus results in an engraving track whose side walls likewise run to the base of the engraving at a 45° angle. This example shows that different wall inclinations can be produced in the engraving plate by producing gravers with different angles. Along with the wall gradient one can also influence the wall form via the forming of the engraving tool. Fig. 9(b) shows in this connection cross-sectional line 29 of a rotationally symmetric engraving point with which different angular degrees of the engraving walls can be produced at different engraving depths. These two examples indicate that the use of different engraving tools considerably influences the desired engraving result, and optimal results can be achieved for a certain line original with the aid of specially produced engraving tools or engraving tool points. In particular it is possible to produce the engraving tools in their angle and form so that they can remove even very fine areas to be engraved, whereby in the case of fine lines the tool track along which the engraving tool is guided leads along the predetermined line only once within the area to be removed. Due to the special form of the engraving tool, the material within the desired contour is thus removed by a sin-

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gle working traverse of the graver. In these cases, the tool track can also lead along a center line located between two desired contour lines and equidistant from the two. A suitable chisel form must then be selected at a given depth profile.

The inventive method offers the crucial advantage that engraving can be performed with exact line control even with extremely small engraving areas or lines. The desired depths which can be reached with the inventive method are preferably between 10 and 150 microns, whereby the desired depths can also be preset by different gray-level values of the line original.

9 If the original is formed for example by a uniform line pattern, e.g. a guilloche, one can bring in visible information, for example a portrait, by varying the line depth, line width, line density or contour by the method described above. Instead of visually recognizable information, however, one can also bring in different, for example machine-readable, information in this way.

Although the use of different engraving tools already provides a wealth of pos-
substructures in the form of
B sibilities for bringing into the embossing plate defined roughness structures at the base of the engraving or additional information, which can be called micro-engraving in the present case, the inventive method can of course also be used to modify the flanks of the engraving along the desired contours. Fig. 10 shows an ex-
bringing substructures into the embossing plate
B ample ~~of this~~ whereby an engraving consisting in the present case of flank 28 and
15 and, in
B engraving 29 located on the bottom is brought into embossing plate ~~15. In~~ an addi-
specific substructures made up of
B tional operation, additional information in the form of so-called ~~sub- or~~ microstructure lines 30 was brought into flank 28. The flank of the engraved line can thus be provided with an additional information content which can consist for example of simple lines, a step function, characters, patterns, pictures or the like. In particular in the case of gently sloping flanks 28 it is therefore also possible to bring additional information into the flank of an engraved line which extends downward from desired contour line 26.

The inventive method can of course also be employed if a negative image of the line original is to be produced. As shown in Fig. 11, the above-described calculation of the tool track can also be performed if further surface area 25 to be excluded from removal is located within the area to be removed. The tool track is pref-

erably calculated so that the engraving tool runs down the workpiece, i.e. the embossing plate, in a first step such that the embossing plate is removed along desired contour line 26. In a further step, the engraving tool is guided along second desired contour 27 while a residual area possibly remaining between desired contours 26 and 27 is cleared out, as described above.